CLAIMS

We claim:

1. A beverage dispenser, comprising:

   beverage dispenser components comprising at least:

   a user interface,

   a dispensing valve, and

   a valve interface for regulating the delivery of a beverage from the dispensing valve; and

   an electronic control system, comprising:

   a microcontroller for monitoring the user interface and for activating the valve interface responsive to user input, thereby regulating the delivery of a beverage from the dispensing valve, and

   a program memory including firmware configured in a state machine system architecture for controlling the microcontroller.

2. The beverage dispenser according to claim 1, wherein the state machine system architecture supports a non-preemptive multitasking real time operating system.

3. The beverage dispenser according to claim 1, wherein the state machine system architecture supports a preemptive multitasking real time operating system.

4. The beverage dispenser according to claim 1, wherein the firmware comprises supervisory control firmware, dispenser tasks firmware, and low level drivers firmware.

5. The beverage dispenser according to claim 1, wherein the firmware comprises dispenser tasks firmware for directing the microcontroller during the performance of tasks associated with beverage dispenser operation.

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6.   The beverage dispenser according to claim 5, wherein the dispenser tasks firmware comprises a state machine for each task associated with beverage dispenser operation.

7.   The beverage dispenser according to claim 6, wherein the firmware comprises supervisory control firmware for calling each state machine of the dispenser tasks firmware.

8.   The beverage dispenser according to claim 6, wherein the firmware comprises supervisory control firmware for coordinating the activities and communications between each state machine of the dispenser tasks firmware.

9.   The beverage dispenser according to claim 5, wherein the firmware comprises low level drivers firmware that interfaces the dispenser tasks firmware with the microcontroller.

10.   The beverage dispenser according to claim 5, wherein the firmware comprises low level drivers firmware that interfaces the dispenser tasks firmware with dedicated peripherals of the microcontroller.

11.   The beverage dispenser according to claim 1, wherein the firmware comprises low level drivers firmware that interfaces the microcontroller with the beverage dispenser components.

12.   The beverage dispenser according to claim 4, wherein changing beverage dispenser components requires modification of the low level drivers firmware without any corresponding modification of the supervisory control firmware and the dispenser tasks firmware.

13.   The beverage dispenser according to claim 4, wherein adding beverage dispenser components requires modification of the low level drivers firmware and addition of a dispenser tasks firmware state machine and corresponding modification of the supervisory control firmware without modification of existing dispenser tasks firmware state machines.

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14.   The beverage dispenser according to claim 4, wherein changing to a different valve interface requires modification of the low level drivers firmware and substitution of a dispenser tasks firmware state machine associated with the different valve interface without any corresponding modification of the supervisory control firmware and other dispenser tasks firmware state machines.

15.   The beverage dispenser according to claim 4, wherein changing ratio control parameters associated with a beverage dispense requires modification of a beverage dispense state machine of the dispenser tasks firmware without any corresponding modification of the supervisory control firmware, the low level drivers firmware, and other dispenser tasks firmware state machines.

16.   The beverage dispenser according to claim 4, wherein changing a beverage dispense ratio through physical means requires substituting components of the valve interface without any corresponding modification of the supervisory control firmware, the dispenser tasks firmware, and the low level drivers firmware.

17.   The beverage dispenser according to claim 11, wherein the electronic control system is configured for implementation in any beverage dispenser with modification of only the low level drivers to permit interfacing of the microcontroller to beverage dispenser components.

18.   The beverage dispenser according to claim 4, wherein changing electronic control system hardware requires modification of the low level drivers firmware without any corresponding modification of the supervisory control firmware and the dispenser tasks firmware.

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19. The beverage dispenser according to claim 4, wherein adding electronic control system hardware requires modification of the low level drivers firmware and addition of a dispenser tasks firmware state machine and corresponding modification of the supervisory control firmware without modification of existing dispenser tasks firmware state machines.

20. The beverage dispenser according to claim 1, wherein the electronic control system further comprises an interface to permit communication with external devices.

21. The beverage dispenser according to claim 20, wherein the interface comprises an RS-232 interface.

22. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a device interface that permits the electronic control system to monitor and control a wide variety of devices attached to the beverage dispenser.

23. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a modem to permit communication with remotely located external devices.

24. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a power supply to furnish the power levels required by the electronic control system.

25. The beverage dispenser according to claim 24, wherein the electronic control system further comprises a replaceable battery to furnish the power levels required by the electronic control system in the event of a power interruption.

26. The beverage dispenser according to claim 25, wherein the electronic control system further comprises a battery controller that switches between the power supply and the replaceable battery.

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27. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a memory for storing time and date stamped sales, diagnostic, and service information.

28. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a real time clock.

29. The beverage dispenser according to claim 1, wherein the user interface comprises a lever activated switch.

30. The beverage dispenser according to claim 1, wherein the user interface comprises a push button switch.

31. The beverage dispenser according to claim 1, wherein the user interface comprises a keypad switch matrix.

32. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a refrigeration control for interfacing the electronic control system with a refrigeration unit of the beverage dispenser.

33. The beverage dispenser according to claim 1, wherein the electronic control system further comprises a carbonation control for interfacing the electronic control system with a carbonation system of the beverage dispenser.

34. The beverage dispenser according to claim 1, wherein the valve interface comprises a solenoid operated valve.

35. The beverage dispenser according to claim 1, wherein the valve interface comprises volumetric valve technology.

36. The beverage dispenser according to claim 1, wherein the dispensing valve comprises any suitable pre- or post-mix valve capable of delivering a flow of beverage therefrom.

37. A beverage dispenser, comprising:

beverage dispenser components, comprising at least:

a user interface,

a dispensing valve, and

a valve interface for regulating the delivery of a beverage from the dispensing valve; and

an electronic control system, comprising:

a microcontroller for monitoring the user interface and for activating the valve interface responsive to user input, thereby regulating the delivery of a beverage from the dispensing valve;

a program memory including firmware for controlling the microcontroller, and

an interface to permit communication with external devices.

38. The beverage dispenser according to claim 37, wherein the interface comprises an RS-232 interface.

39. A beverage dispenser, comprising:

beverage dispenser components, comprising at least:

a user interface,

a dispensing valve, and

a valve interface for regulating the delivery of a beverage from the

dispensing valve; and

an electronic control system, comprising:

a microcontroller for monitoring the user interface and for activating the

valve interface responsive to user input, thereby regulating the delivery of a

beverage from the dispensing valve,

a program memory including firmware for controlling the microcontroller,

and

a device interface that permits the electronic control system to monitor and

control a wide variety of devices attached to the beverage dispenser.

40.   A beverage dispenser, comprising:

beverage dispenser components, comprising at least:

a user interface,

a dispensing valve, and

a valve interface for regulating the delivery of a beverage from the

dispensing valve; and

an electronic control system, comprising

a microcontroller for monitoring the user interface and for activating the

valve interface responsive to user input, thereby regulating the delivery of a

beverage from the dispensing valve,

a program memory including firmware for controlling the microcontroller,

and

a modem to permit communication with remotely located external devices.

41.	A method of designing a beverage dispenser or re-configuring an existing beverage dispenser, comprising the steps of:

providing beverage dispenser components, comprising at least:

a user interface,

a dispensing valve, and

a valve interface for regulating the delivery of a beverage from the dispensing valve;

providing an electronic control system, comprising:

a microcontroller for monitoring the user interface and for activating the valve interface responsive to user input, thereby regulating the delivery of a beverage from the dispensing valve, and

a program memory including supervisory control firmware, dispenser tasks firmware, and low level drivers firmware for controlling the microcontroller; and

modifying the low level drivers firmware to interface the microcontroller with the beverage dispenser components.

42.	The method of designing a beverage dispenser or re-configuring an existing beverage dispenser according to claim 41, further comprising the steps of:

substituting one beverage dispenser component for another similar beverage dispenser component; and

modifying the low level drivers firmware to interface the microcontroller with the substituted beverage dispenser component.

43. The method of designing a beverage dispenser or re-configuring an existing beverage dispenser according to claim 41, further comprising the steps of:

adding a beverage dispenser components;

modifying the low level drivers firmware to interface the microcontroller with the added beverage dispenser component;

adding a dispenser tasks firmware state machine; and

modifying the supervisory control firmware to call the added dispenser tasks firmware state machine.

44. The method of designing a beverage dispenser or re-configuring an existing beverage dispenser according to claim 41, further comprising the steps of:

substituting one valve interface for another valve interface; and

modifying the low level drivers firmware to interface the microcontroller with the substituted valve interface.

45. The method of designing a beverage dispenser or re-configuring an existing beverage dispenser according to claim 41, further comprising the steps of:

inputting ratio control parameters associated with a beverage dispense into the program memory; and

modifying a beverage dispense state machine of the dispenser tasks firmware utilizing the inputted ratio control parameters.

46. The method of designing a beverage dispenser or re-configuring an existing beverage dispenser according to claim 41, further comprising the step of substituting components of the valve interface, thereby changing the dispense ratio through physical means.

47.   The method of designing a beverage dispenser or re-configuring an existing beverage dispenser according to claim 41, further comprising the steps of:

substituting electronic control system hardware for existing electronic control system hardware; and

modifying the low level drivers firmware to interface the substituted electronic control system hardware.

48.   A method of receiving user input into a beverage dispenser, comprising the steps of:

providing a beverage dispenser, comprising:

a push-button switch, and

an electronic control system, comprising:

a microcontroller for controlling the push-button switch, and

a program memory including a switch state machine for controlling the microcontroller, wherein the switch state machine includes an off state and an on state;

calling the switch state machine to assume control of the microcontroller;

monitoring in the off state for the depression of the push button switch;

changing from the off state to the on state upon the depression of the push-button switch;

receiving in the on state via the push button switch user input for use by the beverage dispenser;

changing from the on state to the off state upon the release of the push-button switch; and

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relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

49.   The method of receiving user input into a beverage dispenser according to claim 48, further comprising the steps of:

providing the switch state machine including a masked state;

changing from the on state to the masked state when the push button switch has remained depressed longer than a maximum time period; and

changing from the masked state to the off state upon the release of the push-button switch.

50.   A method of outputting information from a beverage dispenser to a user, comprising the steps of:

providing a beverage dispenser, comprising:

a user interface device, and

an electronic control system, comprising:

a microcontroller for controlling the user interface device, and

a program memory including a user interface state machine for controlling the microcontroller, wherein the user interface state machine includes an activate state and a deactivate state;

calling the user interface state machine to assume control of the microcontroller;

monitoring in the activate state for a condition requiring the activation of the user interface device;

activating the user interface device upon the detection of a condition requiring the activation of the user interface device;

changing from the activate state to the deactivate state after activating the user

interface device;

monitoring in the deactivate state for a condition requiring the deactivation of the

user interface device;

deactivating the user interface device upon the detection of a condition requiring

the deactivation of the user interface device;

changing from the deactivate state to the activate state after deactivating the user

interface device; and

relinquishing control of the microcontroller when there has been no change of

state, immediately upon a change of state, or upon the expiration of a preset time period.

51.   A method of dispensing a beverage from a beverage dispenser, comprising the

steps of:

providing a beverage dispenser, comprising:

a dispensing valve,

a valve interface for regulating the delivery of a beverage from the

dispensing valve, and

an electronic control system, comprising:

a microcontroller for controlling the valve interface, thereby

regulating the delivery of a beverage from the dispensing valve, and

a program memory including a dispense state machine for

controlling the microcontroller, wherein the dispense state machine

includes a detect dispense

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calling the dispense state machine to assume control of the microcontroller;

detecting in the detect dispense state whether a dispense has been requested;

changing from the detect dispense state to the dispense state upon the request of a dispense;

activating in the dispense state the valve interface to deliver a beverage from the dispensing valve;

changing from the dispense state to the dispense over state upon the activation of the valve interface;

monitoring in the dispense over state whether the dispense request has been discontinued, whether a preset volume of beverage has been dispensed from the dispensing valve, or whether a preset time period has expired;

changing from the dispense over state to the stop dispense state upon the discontinuing of the dispense request, the dispensing of a preset volume of beverage from the dispensing valve, or the expiration of a preset time period;

deactivating in the stop dispense state the valve interface to stop delivery of a beverage from the dispensing valve;

changing from the stop dispense state to the detect dispense state upon the deactivation of the valve interface; and

relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

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52.   A method of external communication to a beverage dispenser, comprising the steps of:

providing a beverage dispenser, comprising:

an electronic control system, comprising:

an interface to permit communication with an external device;

a microcontroller for controlling the interface, and

a program memory including an interface state machine for controlling the microcontroller, wherein the interface state machine includes a message state and a receive state;

calling the interface state machine to assume control of the microcontroller;

determining in the message state whether an external device contains information for the beverage dispenser;

changing from the message state to the receive state when an external device contains information for the beverage dispenser;

inputting via the interface information from an external device to the beverage dispenser;

changing from the receive state to the message state upon the completion of information input from an external device to the beverage dispenser; and

relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

53.   A method of external communication from a beverage dispenser, comprising the

steps of:

     providing a beverage dispenser, comprising:

          an electronic control system, comprising:

               an interface to permit communication with an external device;

               a microcontroller for controlling the interface, and

               a program memory including an interface state machine for

          controlling the microcontroller, wherein the interface state machine

          includes a message state and a transmit state;

     calling the interface state machine to assume control of the microcontroller;

     determining in the message state whether the beverage dispenser contains

information for an external device;

     changing from the message state to the transmit state when the beverage dispenser

contains information for an external device;

     outputting via the interface information from the beverage dispenser to an

external device;

     changing from the transmit state to the message state upon the completion of

information output from the beverage dispenser to an external device; and

     relinquishing control of the microcontroller when there has been no change of

state, immediately upon a change of state, or upon the expiration of a preset time period.

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54.   A method of remote external communication to a beverage dispenser, comprising the steps of:

providing a beverage dispenser, comprising:

an electronic control system, comprising:

a modem to permit communication with a remote external device;

a microcontroller for controlling the modem, and

a program memory including a modem state machine for controlling the microcontroller, wherein the modem state machine includes a message state and a receive state;
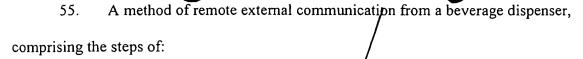
calling the modem state machine to assume control of the microcontroller;

determining in the message state whether a remote external device contains information for the beverage dispenser;

changing from the message state to the receive state when a remote external device contains information for the beverage dispenser;

inputting via the modem information from a remote external device to the beverage dispenser;

changing from the receive state to the message state upon the completion of information input from a remote external device to the beverage dispenser; and

relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

55. A method of remote external communication from a beverage dispenser, comprising the steps of:

providing a beverage dispenser, comprising:
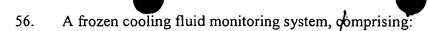
an electronic control system, comprising:

a modem to permit communication with a remote external device;

a microcontroller for controlling the modem, and

a program memory including a modem state machine for controlling the microcontroller, wherein the modem state machine includes a message state and a transmit state;

calling the modem state machine to assume control of the microcontroller;

determining in the message state whether the beverage dispenser contains information for a remote external device;

changing from the message state to the transmit state when the beverage dispenser contains information for a remote external device;

outputting via the modem information from the beverage dispenser to a remote external device;

changing from the transmit state to the message state upon the completion of information output from the beverage dispenser to a remote external device; and

relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

56.   A frozen cooling fluid monitoring system, comprising:

a first probe immersed in a cooling fluid;

a second probe immersed in the cooling fluid;

a ground probe immersed in the cooling fluid;

a controller coupled with the first probe and the second probe, wherein the

controller outputs a pulse signal received at the first probe and the second probe,

whereby, when both the first probe and the second probe are submerged in frozen cooling

fluid, the controller receives a pulse signal indicating a sufficient amount of frozen

cooling fluid, and, when the first probe is submerged in frozen cooling fluid and the

second probe is immersed in unfrozen cooling fluid, the pulse signal is attenuated to

ground via the ground probe indicating to the controller an insufficient amount of frozen

cooling fluid.

57.   A method of controlling a refrigeration unit of a beverage dispenser, comprising

the steps of:

providing a beverage dispenser, comprising:

        a refrigeration unit including a frozen cooling fluid monitoring system;

and

        an electronic control system, comprising:

                a refrigeration control to permit interfacing with the refrigeration

unit;

                a microcontroller for controlling the refrigeration control, and

                a program memory including a refrigeration state machine for

controlling the microcontroller, wherein the refrigeration state machine

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includes an off state, an unfrozen probes state, an on state, a frozen probes state;

calling the refrigeration state machine to assume control of the microcontroller;

deactivating in the off state the refrigeration unit via the refrigeration control;

changing from the off state to the unfrozen probes state;

determining in the unfrozen probes state via the frozen cooling fluid monitoring system when there is insufficient frozen cooling fluid;

changing from the unfrozen probes state to the on state when the frozen cooling fluid monitoring system registers that there is insufficient frozen cooling fluid;

activating in the on state the refrigeration unit via the refrigeration control;

changing from the on state to the frozen probes state;

determining in the frozen probes state via the frozen cooling fluid monitoring system when there is sufficient frozen cooling fluid;

changing from the frozen probes state to the off state when the frozen cooling fluid monitoring system registers that there is sufficient frozen cooling fluid; and

relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

58.   The method of controlling a refrigeration unit of a beverage dispenser according to claim 57, further comprising the steps of:

providing the refrigeration state machine including an off timer state;

activating in the off state an off timer;

changing from the off state to the off timer state prior to changing to the unfrozen probes state;

determining in the off timer state when the off timer expires; and

changing from the off timer state to the unfrozen probes state upon the expiration of the off timer.

59.   The method of controlling a refrigeration unit of a beverage dispenser according to claim 57, further comprising the steps of:

activating in the on state an on timer;

determining in the frozen probes state if the on timer has expired; and

changing from the frozen probes state to the off state upon the expiration of the on timer.

60.   A liquid level monitoring system, comprising:

a first probe extending into a liquid container;

a second probe extending into the liquid container;

a ground probe attached to the liquid container;

a controller coupled with the first probe and the second probe, wherein the controller outputs a pulse signal received at the first probe and the second probe, whereby, when both the first probe and the second probe are not contacted by liquid in the liquid container, the controller receives a pulse signal indicating an insufficient amount of liquid in the liquid container, and, when both the first probe and the second probe are contacted by liquid in the liquid container, the pulse signal is attenuated to ground via the ground probe indicating to the controller a sufficient amount of liquid in the liquid container.

61.   A method of controlling a carbonation system of a beverage dispenser, comprising the steps of:

providing a beverage dispenser, comprising:

a carbonation system including a liquid level monitoring system; and

an electronic control system, comprising:

a carbonation control to permit interfacing with the carbonation system;

a microcontroller for controlling the carbonation control, and

a program memory including a carbonation state machine for controlling the microcontroller, wherein the refrigeration state machine includes an off state, a probes exposed state, an on state, a probes unexposed state;

calling the carbonation state machine to assume control of the microcontroller;

deactivating in the off state a pump of the carbonation system via the carbonation control;

changing from the off state to the probes exposed state;

determining in the probes exposed state via the liquid level monitoring system when there is insufficient liquid in the carbonation system;

changing from the probes exposed state to the on state when the liquid level monitoring system registers that there is insufficient liquid in the carbonation system;

activating in the on state the pump of the carbonation system via the carbonation control;

changing from the on state to the probes unexposed state;

determining in the probes unexposed state via the liquid level monitoring system when there is sufficient liquid in the carbonation system;

changing from the probes unexposed state to the off state when the liquid level monitoring system registers that there is sufficient liquid in the carbonation system; and

relinquishing control of the microcontroller when there has been no change of state, immediately upon a change of state, or upon the expiration of a preset time period.

62.   The method of controlling a carbonation system of a beverage dispenser according to claim 61, further comprising the steps of:

activating in the on state an on timer;

determining in the probes unexposed state if the on timer has expired; and

changing from the probes unexposed state to the off state upon the expiration of the on timer.